A New Prescription: Pollution Prevention Strategies for the Health Care Industry

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Boston University Corporate Education Center
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Proceedings

Section 3: Laboratories

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More detailed information about these efforts have been published by Dr. Denys in Pollution Prevention and Waste Minimization in Laboratories, edited by Reinhardt, Leonard and Ashbrook and published in 1996 by CRC Press.

Waste Minimization in the Clinical Laboratories

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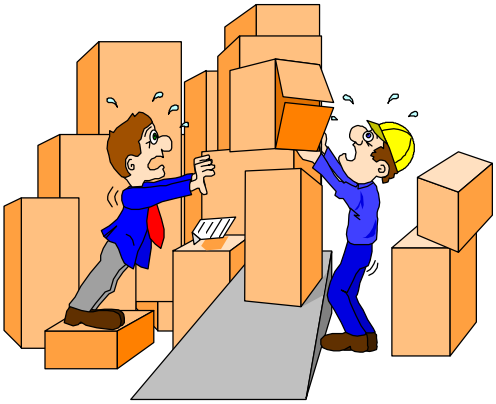
October 7, 1998



Objectives

- Discuss Management Practices to Minimize Waste Generation
- Identify Ways to Reduce Waste Through New Technology and Product Substitution
- Discuss the Reuse of Wastes
- Review Components of a Waste Reduction Program

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Considerations for Waste Minimization

- Regulatory requirements to reduce and minimize the quantities of waste generated
- Cost savings; smaller quantities of waste to manage and dispose.
- Cost savings; some waste are reused or recycled
- Increase environmental awareness
- Institutional concerns about community relations.

According to 40 CFR 262.41 (the Resource Conservation and Recovery Act), each generator of hazardous waste must undertake efforts to reduce the volume and toxicity of waste generated. This effort is certified each time the generator signs a manifest for the transport of hazardous waste.

Minimization of Waste Through Management Practices

- Formalize a Strict Definition of Waste Type
- Implement Source Separation of Different Waste Types
- Institute a Product Substitution Policy
- Utilize computers or software to help track and manage waste

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Implementation of Source Separation

- Infectious Wastes
- Chemical Wastes
- Radioactive Wastes
- Multihazardous Wastes
- Wastewater
- General Wastes (Amenable to Reuse or Recycling)

Categories of Infectious Waste

- Microbiology and Pathology Waste
- Blood and Blood Products
- Contaminated (Unused) Sharps
- Culture, Stocks, Associated Biologicals
- Contaminated Animals, Body Parts, Bedding
- Wastes from Surgery and Autopsy
- Contaminated Equipment
- Contaminated Laboratory Wastes
- Dialysis Unit Wastes

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Chemical Wastes Separation

- Chemicals suitable for disposal to sanitary sewer
- Chemicals that can be redistilled for reuse
- Solvents that can be incinerated for heat recovery
- Hazardous chemicals that can be treated to neutralize
- Hazardous chemical wastes that are regulated by RCRA that cannot be treated or disposed of on-site

Other Waste Suitable for Reuse or Recycling

- Paper (e.g.computer, newspaper)
- Plastics (e.g. petri dishes, culture tubes)
- Aluminum (e.g.cans)
- Glass (e.g. bottles, slides)
- Packaging materials and containers (e.g. Styrofoam, corrugated cardboard, plastic wrappers and containers, wooden palets)

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Benefits of
Source Separation

- Safety and minimization of potential for exposure
- Minimization of waste quantities
- Efficiency
- Regulatory compliance
- Reduction in liability
- Cost reduction

Product Substitution

- Nonradioactive test methods
  - » chemiluminescent compounds
  - » fluorogenic sensors
  - » colorimetric sensors
- Reusable for disposable (single-use) items
- Process modifications
  - » microsamples of specimen
  - » consolidation of test methods
- Paperless laboratory

Nonradioactive Methods: - Microbial Detection:
Bactec 9240 (Becton Dickinson Diagnostic Instrument systems) (fluorogenic sensor)
BacT/Alert (Organaon Teknika Corp) (colorimetric sensor)
Microorganism Gas Consumption and Production:
ESP system (AccuMed)

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Hazardous Reagents Substitution

- Mercury-containing reagents
  - » ion-selective electrodes replaces mercuric nitrate for chloride determination in body fluids.
  - » electronic apparatus replaces lab thermometers
- Sodium lauryl sulfate provides alternative to cyanide methods for automated hemoglobin analysis
- Cupric sulfate substitutes for mercuric chloride as a fixative for PVA/trichrome stain
- Substitute nonsilver stains for silver stains

Minimization of Waste Through New Technology

- Microbiology
- Immunology
- Chemistry
- Hematology

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New Technologies To Minimize Toxic and Hazardous Waste

Microbiology:

Micromethods reduce the amount of sample and reagents required. Micromethods for identification of antimicrobial susceptibility of microorganisms include:

API system (bioMerieux Vitek, Inc.)
Biology system (Biolog, Inc.)
BBL Crystal system (Becton Dickinson Microbiology Systems)
Raid ID systems (Innovative Diagnostic Systems, Inc.)

Some instruments combine identification and antimicrobial test panels which reduce the quantitiy of waste and make testing more efficient. Examples of automated walkaway identification and susceptibility instruments are:

Dade MicroScan system (Dade International)
Vitek System (bioMerieux Vitek, Inc.)

(The Vitek system requires smaller test volumes and fewer preparation devices.)

Rapid screening tests can eliminate specimens that need not be cultured; these methods often generate less waste than conventional methods. Rapid urine screen methods utilize the enzyme dipstick, filtration, bioluminescence, chemiluminescence, and photometry.

Rapid screen tests for bacterial identification include:

Butyrate esterase disc test for Moraxella catarrhalis
PYR disc test for Streptococcus yogenes
PYR disc test for Group D enterococci
Rapid urease test for Helicobacter pylori
Spot indole test for Escherichia coli

DNA probe-based tests can be used as alternatives to confirmatory tests. The Accuprobe culture confirmation test for mycobacteria (Gen-Probe, Inc.) is one such test which can eliminates conventional biochemical testing.

Molecular Diagnostics:

DNA amplification techniques can allow for direct specimen testing and further reduce infection wastestreams by eliminating unnecessary cultures.

PCR (polyerase chain reaction, Roche Molecular Systems)
TMA (transcription mediated amplification, GenProbe, Inc.)
DSA (strand displacement amplification, Becton Dickinson Microbiology Systems)
LCX (ligase chain reaction, Abbott Laboratories)

Immunology/Serology:

Consolidation of test methods minimizes quantities of waste generated. These systems conduct several different immunoassays simultaneously.

IMX (Abbott Laboratories)
ACS-Centaur, Automated Chemiluminescence System (Chiron Diagnostics)

Chemistry/Hematology:

Automated analyzers which require only microsamples of specimen also reduce the amount of reagent used. Examples of these include:

Dade Dimension RXL Clinical Chemistry System (Dade International; encapsulates waste)
Sysmex Hematology System (Sysmex)
Sysmex CA-6000 Coagulation System (Sysmex)

Other options to reduce reagent use and waste generation include:

Ektachem dry slide chemistry analyzer (Johnson & Johnson; eliminates the generation of hazardous waste).
Dako Autostainer Universal Staining System (Dako Corp; separates hazardous from non-hazardous waste)
i-STAT analyzer (i-StAT Corp; analyzes two drops of blood using biosensors to measure sodium, potassium, and other analytes.)

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Federal Regulation Affecting Management and Disposal of Wastes from Medical Laboratories

Waste Type	Federal Regulation	Agency
Infectious	Medical waste tracking Bloodborne pathogens standard	EPA OSHA
Chemical	Hazardous waste management	EPA
Radioactive	Radioactive waste disposal	NRC
Wastewater	Effluent guidelines and standards	EPA

On-Site Treatment of Infectious Waste

- Incineration
- Steam/Autoclave
- Steam/Mechanical
- Chemical
- Electric/Thermal/Radiation
- Microwave
- Pyrolysis/Oxidation

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On-Site Treatment of Chemical Waste

- Recycling for Reuse
  - » Redistillation of used solvents
  - » Incineration of solvents with heat recovery
- Neutralization of acids and bases
- Treatment to destroy or precipitate out hazardous constituents
- Sanitary Sewer System

Implementing a Waste Reduction Program

- Management Program
- Purchasing Strategies
- Employee Awareness Program
- Employee Training
- Cost Savings: Administration Support

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Strategies to Minimize Infectious & Hazardous Waste

- Segregate infectious waste from noninfectious general trash
- Collect blood and other clinical specimens in smaller containes
- Aliquot blood samples instead of obtaining separate sample tubes
- Substitute micromethods for conventional procedures
- Increase use of screening tests
- Consolidate test methodologies

Strategies to Minimize Infectious & Hazardous Waste

- Substitute nonradioactive for radioactive tests
- Store low-level radioactive waste on-site for decay
- Track all purchased hazardous materials
- Eliminate use of mercury-based fixatives and reagents
- Reduce the amount of wasted silver by recovery, precipitation, and substitution
- Consider use of alternative clearing agents and less-toxic reagents

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Strategies to Minimize Infectious & Hazardous Waste

- Distill formaldehyde for reuse
- Distill xylene and alcohol for reuse or direct to a reclamation facility
- Consider alternative waste treatment and disposal option
- Develop an education program to promote recycling, product reuse, and waste reduction

Purchasing Strategies

- Elimination of inner liners and boxes
- Elimination of toxic metals in inks,dyes, and adhesives
- Elimination of chlorine-bleached paper and paperboard
- Elimination of foam packaging made of chlorofluorocarbons
- Maximized use of recycled fiber in corrugated shipping containers
- Reduction in primary, secondary, and tertiary packaging where feasible
- Promotion of bulk shipping and reusable containes
- Adoption of guidelines for the evaluation of new packaging designs

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Employee Awareness Program

- Obtain support and cooperation of employees
- Provide information about purpose, scope and benefit
- Provide specific information about wastes that can be reused or recycled
- Provide procedures for handling each of the wastes and importance of following these procedures
- Present information as part of the training program for all employees who generate, collect or handle wastes

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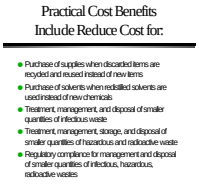

Summary

- A successful waste minimization program will help control costs and comply with regulation.
- Waste minimization takes effort and management backing and support to facilitate every step from the initial purchase of a product through proper storage to disposal.

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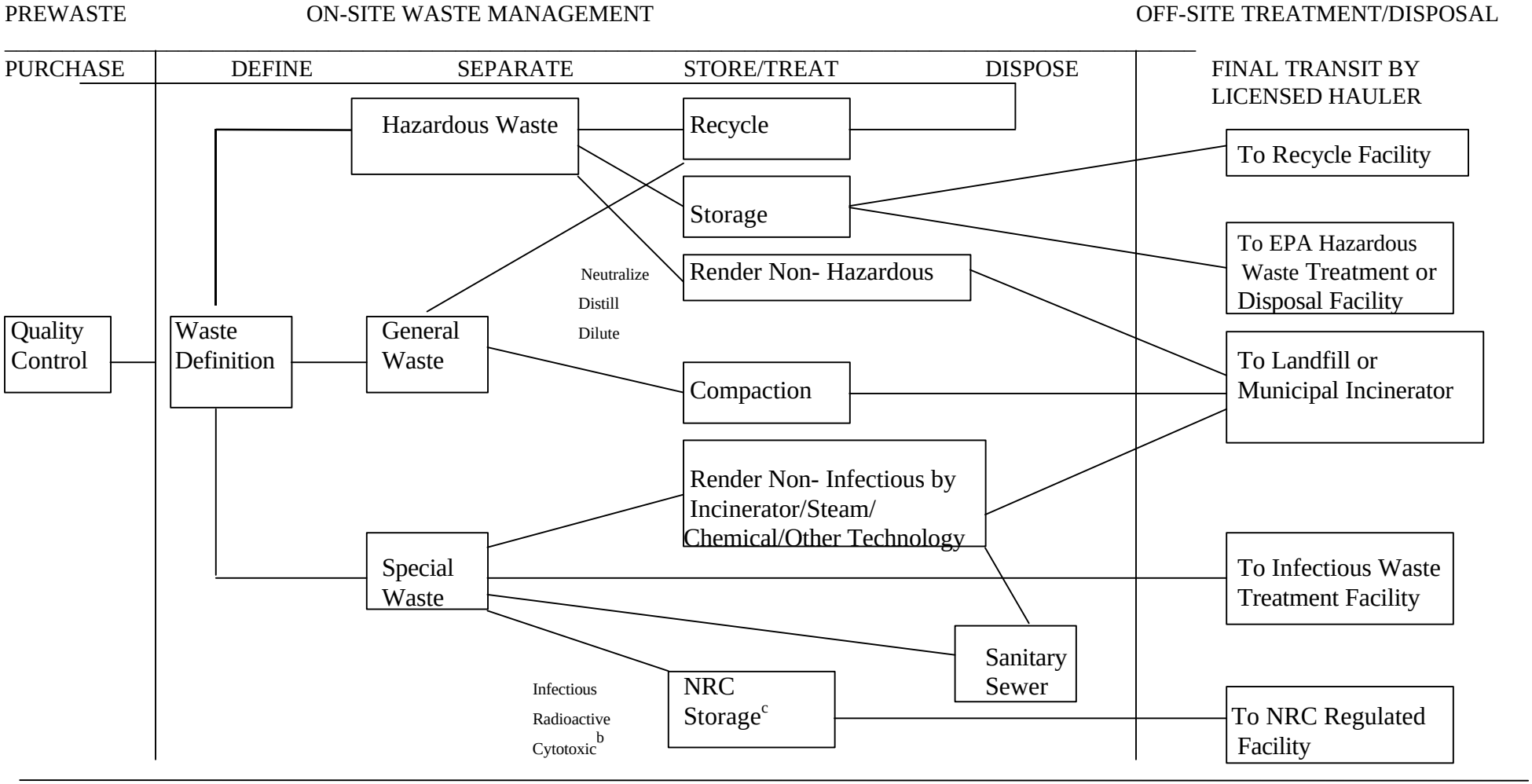
Figure 1. Medical Waste Management Planning and Implementation Process.[a]



[a] Adapted from Denys, G.A., Infectious Waste Management. In: J. Lederberg, ed. Encyclopedia of Microbiology. Academic Press, Orlando, FL, 1992, 493-504.
[b] Some cytotoxic waste must be managed as hazardous waste.
[c] After decay in storage (DIS), waste can be disposed of as non-regulated waste.

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Hazardous Waste Reduction in Surgical Pathology

Introduction

As regulations change and natural resources dwindle, it is important that health care providers have a proactive waste reduction plan[1]. The Surgical Pathology Department at the VA Medical Center, Albuquerque, New Mexico, incorporates several strategies in our waste reduction plan. Strategies may include: reducing, substituting, or recycling hazardous wastes.

Our waste reduction strategy starts by defining the procedures and chemicals involved in producing a product. A product may be defined as: fixing a specimen, producing a microscopic slide, or it may even include the disposal methods for hazardous wastes. Next, we determine if a component involved in the process may be reduced, substituted, or recycled. After a component has been identified, we review the item to determine if, by eliminating one problem, we are not creating additional hazardous waste or increasing our costs. For example, osmium tetroxide may be recycled. However, the byproducts of recycling osmium pose a greater problem of waste disposal, than a few grams of oxidized osmium. Likewise, a smaller specimen container may reduce the amount of fixative used. However, the type of material the container is composed of, may have trace elements that could increase the costs associated with it's disposal.

The most successful strategy to reduce hazardous wastes for us is to reduce the volume of a substance. We have found that this method has little or no adverse impact on patient care. Furthermore, reducing the volume of a reagent does not require specialized equipment.

Examples of Hazardous Waste Reduction:

Bouin's Fixative:

Initially, the Histology Laboratory was supplying several clinics with small containers filled with 20 ml of Bouin's fixative. In 1995, we examined our Bouin's usage, and started supplying the same clinics with smaller containers filled with only 5 ml of Bouin's, (Evergreen Scientific, 800-421-6261). We still maintained the optimum ratio of fixative to specimen, (10:1) and reduced our Bouin's usage by 4 liters per month.

In late 1997, we re-examined our Bouin's usage and determined that it could be eliminate as a routine fixative for gastrointestinal and genitourinary biopsies.

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Advantages (pre 1997)	*Disadvantages*
Reduced chemical usage and costs	None
Reduced chemical wastes	
Smaller containers cost less	
New containers require less storage space	
Reduced disposal cost for used containers, (less weight)	
Reduced employee's possible exposure to toxic chemicals	
Smaller containers did not leak	

Summary:

Old specimen containers .....5.3 liters of Bouin's per month
New specimen containers.....1.3 liters of Bouin's per month
1998 usage of Bouin's fixative.....0.1 liter of Bouin's per month

Bouin's was also eliminated as a stabilizer for specimens that had inked surgical margins. We substituted 10% glacial acetic acid for Bouin's fixative. Household vinegar may also be used to stabilize the inked margins.

Mercury Fixatives:

The same principle of incorporating smaller specimen containers also worked for our B-5 mercury fixative. We reduce the volume of fixative from 50 milliliters per container to 15 milliliters per container.

Advantages:	*Disadvantages:*
Reduced chemical usage	None
Reduced chemical wastes	
Smaller containers cost less	
Smaller containers do not leak	
New containers require less storage space	
Less disposal cost for containers	
Reduced employee's possible exposure to toxic chemicals	

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Summary:

Old specimen containers .....500 milliliters per month
400 grams of $HgCl_2$ per year

New specimen containers.....150 milliliters per month
119 grams of $HgCl_2$ per year

Currently, we are performing side by side evaluations with B-5 fixative and zinc buffered formalin fixative.

Waste Water:

The Histology lab also eliminated a minimum of 39,000 gallons of potable water per year by installing a surplus refrigerated water recirculating unit on the xylene still. The xylene still was originally designed to use tap water to cool the condenser unit. This unit continuously circulates approximately 4 liters of chilled water through the still. As a side note, New Mexico's annual rain fall is 8 inches.

Advantages:	Disadvantages:
Eliminated potable water usage	None
Eliminated mineral build up in the condenser from tap water	

Paraffin:

We do not over fill the embedding molds/cassettes with paraffin when we embed specimens. We save approximately 24 gallons of paraffin per year. Furthermore, used paraffin from embedding units and tissue processors is recycled by adding used paraffin to specimen trays. This system is excellent for "pinning out" large specimens to facilitate fixation.

Advantages:	*Disadvantages:*
Reduced initial cost of paraffin and paraffin block storage units	None
Able to store more paraffin blocks per filing system	
Reduces disposal costs of paraffin blocks	

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Special Stains:

We have reduced the volume of special stain reagents by reducing the size of the staining container, (Evergreen Scientific, 800-421-6261).

Advantages:	*Disadvantages:*
Reduced reagent volumes	Holds only 4 slides
Containers are disposable or re-usable	Not suited for microwave procedures, (shape)
Eliminated stain precipitation vs. flooding stain on slide	

Examples of Substituting Chemicals:

To further reduce the use of mercury in the laboratory setting, we substituted 0.37 grams of sodium iodate for 2.5 grams of mercuric oxide per liter in the hematoxylin stain. This saves an additional 50 grams of mercury per year.

Advantages:	*Disadvantages:*
Mercury free hematoxylin stain performs better	None
Reduced chemical usage	
Reduced chemical wastes	
Reduced employee's possible exposure to toxic chemicals	

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Special Stains:

We are currently using a Diff-Quik® Stain, (Allegiance Scientific Products, 800-9645227) for all GI biopsies, to rule out H. pylori bacteria. This stain has many advantages over a Giemsa stain and a Genta stain.

Diff-Quik®	Giemsa stain	Genta stain
Advantages:	*Advantages:*	*Advantages:*
Reduced chemical usage	Multiple colors	Multiple colors
Reduced chemical wastes		
One step stain 1 to 25 hr		
procedure 2 hours		
Staining time is 3 minutes		
Costs $0.43		
Disadvantages:	*Disadvantages:*	*Disadvantages:*
Monochrome	Cost $2.75	19 steps
		Costs $15.00
		Radioactive chemical
		Silver stain

Examples of Recycling:

All xylene and xylene substitutes are recycled.
Activated charcoal used in the tissue processors may be recycled by autoclaving and reusing it. However, we do not recycle our used charcoal. We found that it was cost prohibitive to autoclave the charcoal.

Autopsy Suite:

We use a portable ultraviolet light system to complete the decontaminating process after autopsies. This unit also reduces the amount of cleaning solutions required after an autopsy. Furthermore, ultraviolet radiation is recommended by OSHA after an autopsy performed on patients with an active case of TB or other biohazards.

Advantages:	*Disadvantages:*
Portable unit decontaminates faster than wall mounted units	UV light hazard
Unit may be used in other areas, (Microbiology or in isolation rooms)	

Reduced the volume of cleaning solutions required after an autopsy	

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Creutzfeldt-Jakobs Disease:

To fix and neutralize neurological tissue containing the Creutzfeldt-Jakobs virus, we use a combination of 20% formalin and 10% bleach. A solution of 20% Formalin and phenol will also neutralize the virus; however, phenol is lethal in high concentrations. Additionally, at our facility, phenol is classified as a hazardous waste and must be shipped off station.

Conclusion

Finally, difficulties in reducing hazardous wastes may be encountered as a facility attempts to balance the customer's needs with production of biological or chemical wastes. However, a proactive waste reduction plan allows a facility the time and resources to test, analyze, and evaluate new strategies to reduce their waste. Waste reduction may be as simple as reducing the volume of a reagent to the acquisition of specialized equipment. Annual review of procedures and chemicals may identify components that can be reduced, substituted, or recycled.
As new commercial products become available, additional hazardous reagents may be eliminated from the health care environment.

References

[1] College of American Pathologist, 1997, "Standards, General Check List," Question: 01:7070 (Phase I). Health Care Providers are required to have a defined program to reduce hazardous wastes

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Mercury Reduction in the Clinical Laboratory

Introduction

This presentation will emphasize reduction of mercury in a Clinical Laboratory setting, but could be implemented for any toxic material. To reduce use of any toxic material you first have to recognize that you have it. Once you identify the material or materials that you need to reduce or eliminate from your facility, you are really faced with three questions:

1) Where do I begin?
2) How do I interpret and utilize results of the investigative process?
3) How do I reduce or eliminate the material?

Newton-Wellesley Hospital began to look at sources of mercury in the laboratory in order to comply with its water discharge permit to the local Water Treatment Plant (Massachusetts Water Resource Authority). This paper will outline the process followed and present the results of our chemical testing and subsequent mercury-reduction activities.

Activities Performed at Newton-Wellesley Hospital to Identify Sources of the Mercury Contamination Problem

1. We identified all reagents used in the department. A database was established using MSDS information and the quantity discharged by the lab. The chemicals were then screened for mercury-containing substances.

2. We segregated waste by department and screened the waste for mercury. First we placed large drums for collection of all waste in all departments. The drums were used to eliminate the possibility of the pipeline as a source of mercury. Aliquots from the drums were tested for mercury. In retrospect the ideal situation would have been a laboratory that is plumbed to segregation of waste streams once plumbing is determined to have below quantitative levels of detectable mercury.

3. All laboratory waste streams which tested positive for mercury were then segregated by bench. Collection stations were placed on every bench and aliquots of those wastes were submitted for analysis. The bench areas from which the mercury-containing waste came were identified. The MSDS for reagents used on these benches were scrutinized, and the manufacturer was contacted for additional information. Suspect reagents were tested for mercury content.

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Laboratory Mercury Contamination: Results of Initial Testing

Laboratory	bench	analytical reports mg/L (Cert. Lab testing)
Chemistry	TDX benches	BQL limit =0.005
Chemistry	IMX benches	BQL limit =0.001
Chemistry	Array	BQL limit =0.002
Chemistry	Flex benches	BQL limit =0.005
Chemistry	E4A bench	BQL limit =0.002
Chemistry	Specials bench (Electrophoresis)	8.8
Chemistry	Plating soln.(leads)	0.6
Cytology	EOSIN stain	BQL limit =0.002
Cytology	OG-6 stain	BQL limit =0.005
Bacti	Casper	10
Bacti	Hepatitis(Abbot)	0.15
Bacti	Probes	0.002
Bacti	Methylene blue	0.002
Bacti	Basic fuchsin	0.002
Bacti	Iodine	BQL
Bacti	Crystal violet	BQL
Bacti	Auramine-Rhodamine	BQL
Bacti	Parasitology (known to contain Hg)	25
Hematology	Coagulation (MLA + Dade Reagents)	BQL
Hematology	IRIS	BQL
Hematology	Technicon H1	BQL
Hematology	Hematoxylin	BQL
Hematology	Coulter T890	BQL
Hematology	Semen analysis (Hematoxylin)	0.04
Hematology	Naphthol and NAP AS-D	BQL
Hematology	LAP	BQL
Hematology	Acid Hemat. Soln.(Sigma) (Peroxidase Satin)	0.01
Hematology	Gill's Hemat.#3 (LAP Counterstain)	BQL
Histology	H&E stainer	BQL
Histology	Floatation water baths (Microtome Stations)	Ranged from 0.008 to 1.18
Histology	VIP fixative	116
Histology	Composite sample	0.001
Histology	Tote waste	0.004

Histology	Water from VIP filter *	0.04
Histology	Processor 1*	8.0
Histology	Stainer rinse 2 *	0.016

Interpretation of Testing Results

Mercury is one of four substances strictly prohibited from sewer discharge. The accepted detection limit based on methods currently acceptable to the EPA is at 0.0002mg/L or 0.2ppb. The threshold for enforcement in Massachusetts (MWRA District) is 0.001mg/L or can also be expressed in micrograms as 1 ug/L or expressed in parts as 1 ppb (part per billion).

MSDS reportable limits: Since heavy metals are considered to be carcinogens or potential carcinogens the concentration limit set by OSHA for manufacturer's to disclose their presence is set at 0.1%. This is equivalent to 0.1g/100ml or 100mg/100ml or 1000 mg/L(1000 ppm). Most manufacturers outside of Massachusetts therefore feel that they have exceeded there responsibility by reporting the presence of mercury when it exceeds the EPA limit of 1 ppm or 1mg/L, as they legally only have to include it on the MSDS when it exceeds 1000 mg/L (1000 pm). This is important to recognize when dealing with manufacturers.

In evaluating a product, we must establish if the product is certified mercury free or if the manufacturer has attempted to test only to the limit set nationally. A company may insist that their product does not contain mercury because the company did not detect its presence at a level of 10 ppm or 1 ppm or higher. It is therefore very critical to ensure that a product to be used in this hospital has been tested to detect mercury at levels at or below 1 ppb not 1ppm.

Below quantitative limits (BQL): This means that the results of the testing demonstrated that there was no mercury detected at the lowest concentration that the laboratory's method for testing for the concentration of mercury in that particular specimen could detect. When BQL is written you need to know what the limits of detection are for the analysis that you had performed.

BQL could be written by some laboratories as <2.00 ug/L with the detection limit stated to be 2.0 ug/L, thus stating that the laboratory analysis as run could not detect levels of mercury below 2.0 ug/L(ppm). When the term BQL is used the laboratory has to state the detection limit.

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Reagents Testing Below Quantitative Levels of Measurement for Mercury

Hematology

Non-specific and Specific esterase Kits
LAP stain
Technicon H1 reagents - measured as a mixture
Coulter T890 reagents - measured as a mixture
IRIS reagents - measured as a mixture
Dade coagulation reagents - used with MLA

Cytology

OG-6
EA-50 mod
EASO stain

Blood Bank

Gamma N-Hance (LISS)
Baxter Certified Blood Bank Saline

Chemistry

Mixture of reagents and a waste sample collected from each of the following instruments and tested:

TDX
IMX
Flex
Array
Beckman E4A
CPK Iso

Continued Testing and Discussion

Histology:
Embedded tissue that had been fixed in VIP or other known mercury containing compounds continued to leach mercury and contaminate other areas of the histology laboratory.
Water baths at microtome stations are the first solutions into which fixed tissues were placed for processing and staining. We should find alternatives for mercury containing stains.

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Newton, Massachusetts

Microbiology

Parasitology stains and preservative contain mercury; alternatives need to be found.
Stains need to be tested and replacements for mercury-based reagents, PVA transport system and preservative need to be found.

Hematology

Few problems with mercury, stains and reagents not a problem.

Chemistry

Testing results from the follow-up of the 8.8 mg/l found in the electrophoresis waste:

Electrophoresis Reagents:
HGBA1C buffer = 0.028 mg/L
IFE buffer = 0.2 mg/L
Elec. Stain = 1.8 mg/Land IFE BQL
Could not account for the 8.8 mg/L detected

Further evaluation led us to the blood bank saline and blood bank.

Blood Bank Reagents:	
Grand mix blood bank reagents	14.3 mg/L
Blood bank waste (plumbing sample)	5.8 mg/L
0.9% sterile saline bags	BQL
Dade certified blood bank saline	0.029 mg/L
Dade immusal (saline)	44.2 mg/L
Immu add (LISS)	0.206 mg/L

Alternative reagents tested:	
Ortho antibody enhancement	0.07 mg/L
Gamma N-Hance	BQL limit (0.0005 mg/L)
BCA EM-X	0.138 mg/L
Grand mix (all reagents + H2O)	BQL limit (0.0005 mg/L)

Toxic Waste Management Program

The analysis and testing done as a result of the mercury problem led to the establishment of a Hospital Mercury Reduction Policy, a method for tracking and following progress of Mercury containing reagents, and establishment in the laboratory of a Waste Reduction Program.

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Mercury Reduction Policy

Purpose: To enable the Hospital to meet mercury level standards established by the federal and state environmental protection agencies and the Massachusetts Water Resources Authority ("MWRA") and requirements of the Hospital's Sewer Use Discharge Permit.

Background: Mercury is a hazardous substance under state and federal environmental laws. The Hospital's Permit and MWRA regulations prohibit the discharge of mercury into the sanitary sewer system. Pursuant to its permit, the hospital must monitor its discharges into the sewer system of several elements, including mercury. Among other enforcement actions, the MWRA may assess monetary penalties for discharges which exceed the standard. Neither government nor private agencies have been able to identify a process by which mercury can be successfully removed from a water stream. The Hospital, therefore, must attempt to prevent mercury from entering its waste water stream in order to protect public health and to avoid penalties.

Policy Statement: Mercury containing products and processes shall not be used in any manner on the Hospital campus, including within the Hospital buildings and medical office buildings, unless no reasonable alternatives, as determined by Hospital Administration, are available. When use of a mercury containing product is permitted, measures shall be taken to avoid introduction of mercury into the sanitary sewer system.

Applicability: Compliance with this policy and its procedures is a condition of employment and a condition of the exercise of clinical privileges or the use of any property located on the Hospital campus. The Hospital reserves its right to take any and all actions, including to seek injunctive relief, to prevent violation of this policy by any party.

Procedures:

I. The Hospital's Departments of Engineering, Environmental Services, Purchasing, Pathology, Radiology, and Safety shall work together to identify product(s) or process(es) containing mercury currently in use on the Hospital campus and to identify acceptable alternatives. A list of such products/processes and their alternatives shall be presented to the Safety Committee that shall arrange for its distribution throughout the Hospital community.

II. When mercury containing products or processes are identified, the manager(s) for the department(s) using such products/processes shall develop a plan to include a.) procedures for the prevention of disposal of any mercury into the sanitary sewer system, b.) a timeframe for the elimination of the use of these products/processes or, in the alternative, the rationale (including information required below at IV) for continued use of such products/processes. The manager(s) shall present the plan to the Safety Committee for review and approval.

III. The Safety Committee shall review all mercury use plans and may approve the plans as submitted or with modification.

IV. Managers of departments using mercury products/processes shall maintain a readily retrievable log of the mercury containing products/processes, the approved use(s), the alternatives considered, the reasons such alternatives were deemed unacceptable, and a time frame for reconsideration of available alternatives.

V. In the event of a mercury spill, employees and physicians shall follow the procedures of Safety Policy #28-8, Handling of Mercury Spills. Managers shall report such spills to the Safety Committee for review.

VI. All employees and physicians shall prevent the disposal of mercury into the sanitary sewer system and shall refrain from using mercury containing products/processes on the Hospital campus unless such use has been approved in accordance with this policy.

VII. All employees and physicians are encouraged to present suggestions for eliminating mercury containing products or processes from the Hospital campus to the Hospital Safety Committee.

Anne Pollack
Newton-Wellesley Hospital
Newton, Massachusetts

FORM FOR TRACKING

PATHOLOGY LABORATORY
MERCURY CONTAINING COMPOUNDS

****

PRODUCT/REAGENT: _____

LABORATORY: _____

MERCURY CONC.: _____ VOL. USED/WEEK _____

DISPOSAL PROCEDURE:

TIME LINE FOR ELIMINATION (INCLUDE ACTION TAKEN TO DATE TO ELIMINATE):

IF CANNOT ELIMINATE, RATIONALE FOR CONTINUING USE:

Anne Pollack
Newton-Wellesley Hospital
Newton, Massachusetts

Hazardous Waste Management Report, Pathology Department, January 1998

We continue our effort to comply with federal, state, and local hazardous waste requirements and to provide strong proactive leadership in hazardous waste reduction.

A major focus of the Pathology Department in 1997 was on the elimination of mercury and a reduction of toxic chemicals at the point of production. Our goal was to improve the workplace, help the environment and at the same time effectively cut chemical purchase and disposal costs.

Toxic use reduction was accomplished by:

1. Reduction in Chemical purchases and better inventory control, using the Meditech Chemical Database.
2. Purchase of equipment that utilized small reagent volumes and generated minimum hazardous waste.
3. Elimination of Hg PVA in Microbiology, replacing with a low Zn PVA system.
4. Replacement of manual staining procedures in Histology with kits continues with elimination of dry chemicals and toxic concentrated stains.
5. Increased employee training in hazardous materials management and mercury source reduction.

In January of 1997, training in hazardous waste management emphasized looking at chemical purchases with emphasis on actual need not restocking, cost of discarding expired reagents, and hazards of having a large inventory of chemicals. Chemical inventories were included as part of the monthly safety audit of each area and employee knowledge of chemical hazards were assessed during the routine safety inspections. As of January of this year the amount of hazardous chemicals we were expiring had decreased by half and safety inspection reports showed an increase in chemical safety knowledge.

Employee training in hazardous materials management and implementation of several chemical disaster drills in the department have heightened employee awareness of their role in handling spills and in controlling chemical waste. The disaster drill reports showed a marked improvement since 1996.

New instruments and procedures are now evaluated for the type and volume of chemicals used and for the impact they will have on our hazardous waste reduction policy. We have seen a reduction in flow volume of nonhazardous waste in the laboratory of 4500 gallons per month average last year to 4000 gallons per month this year. During the same time frame the laboratory has seen an increase in workload volume of as high as 21%.

Anne Pollack
Newton-Wellesley Hospital
Newton, Massachusetts

The total volume of hazardous waste drums generated per week showed no change from 1997, however, the workload volume in Histology alone showed a 23% increase. The fact that we were able to keep our hazardous waste volume at the same level even with an increase in testing volume was due mostly to the reduction in volume of reagents used, and a consorted effort by the employees in Histology to conserve and reduce toxic waste generated.

To comply with the Mercury Reduction Policy, all waste streams in Pathology continue to be tested for mercury; sources of mercury identified, and alternative products continue to be actively sought. As an active participator in the MASCO (Massachusetts Academic and Scientific Community Organization) Mercury Workgroup, we have taken a leadership role in developing protocols for toxic waste management, identifying effective pretreatment technologies, and ultimately reducing wastewater volumes.

The Pathology department is continuing to evaluate formaldehyde and xylene recycling systems. This would significantly reduce the hazardous waste volume sent out each week. We have looked at several excellent, small, safe, and cost effective systems in use in area hospitals. Space and personnel requirements are presently being evaluated by the department.

We continue to seek methods which will offer quality results with minimal chemical exposure and waste production. The ultimate goal is to utilize technology that eliminates employee exposures and toxic waste generation.

Addendum July 1998

Mercury testing in Microbiology revealed a mercury contamination of the sink and staining racks. The sink is on order and staining racks have arrived.

Measurement Units

Milligrams per kilogram or mg/kg equals mg/1000 g of the mixture. This is similar to mg/L as a measurement of a substance concentration; however, mg/kg is not volume based but rather based on the specific gravity of the waste mixture. Expressing concentrations in these terms would eliminate the existing situation where concentration of mercury detected is dependent on the amount of diluent present. In other words, hospital A and hospital B may have the same amount of mercury discharge, but if hospital A has a much higher water usage and discharge than hospital B, hospital A's waste may be in compliance and hospital B’s might not.

Anne Pollack
Newton-Wellesley Hospital
Newton, Massachusetts

Measurement Conversion Chart

Examples of the same concentration expressed in different volumes

Percent	g/100ml	mg/100ml	mg/L	ppm
3%	3g/100ml	3000mg/100ml	30000mg/L	30000 ppm
0.3%	0.3g/100ml	300mg/100ml	3000mg/L	3000 ppm
(not used)	(not used)	30 mg/100ml	300mg/L	300 ppm
(not used)	(not used)	3 mg/100ml	30mg/L	30 ppm
(not used)	(not used)	0.3 mg/100 ml	3 mg/L	3 ppm

mg/L	ug/L	ppm	ppb
3 mg/L	3000 ug/L	3 ppm	3000 ppb
0.3 mg/L	300 ug/L	0.3 ppm	300 ppb
0.03 mg/L	30 ug/L	0.03 ppm	30 ppb
0.003 mg/L	3 ug/L	(not used)	3 ppb
(not used)	0.3 ug/L	(not used)	0.3 ppb

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Robert Winkler
University of Vermont
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Mercury Thermometer Swap: The University Initiative

In January 1997, Environmental Safety Facility technicians became aware of a growing problem; an increase in the number of broken mercury thermometer spills on our campus. Not only was this potentially dangerous, but cleaning up the debris was time consuming, and the resulting disposal costs were expensive. Along with this increase in broken thermometers, the University had also been required by the EPA to have in place a chemical waste minimization program. Since it's opening in January 1994 as a TSD facility, we had seen an increase in chemical waste due to our efforts at cleaning up old chemicals left over in labs, in particular the chemistry building. Documenting that the University was actively engaged in reducing the amount of chemical waste became one of the goals of the ESF. Reducing the number of mercury thermometers on campus became one way to show initiative in that direction. The vehicle we chose for this project was UVM ChemSource, the chemical and safety equipment distribution program for the campus administered through the ESF.

Mercury as a Hazard

Mercury compounds have been used throughout history to chase away evil spirits, change base metals into gold, and as medicine. Of course, the usefulness of mercury is limited by it's poisonous nature. As with most chemicals, there are two types of mercury poisoning-acute and chronic. Acute mercury poisoning results from the ingestion of soluble mercury salts, which corrode skin and mucous membranes. Mercury vapor aspirated into the lungs can cause severe pneumonia and death. Chronic mercury poisoning occurs through the regular absorption of small amounts of mercury. This condition is often a disease of workers in mercury mines, laboratories, and industries that use mercury. Organic mercury compounds, such as dimethyl mercury, are among the most dangerous.

Mercury vapors are colorless, odorless, tasteless, and toxic. When mercury thermometers break, lab and clean-up personnel are exposed to dangerous mercury fumes. An incomplete clean-up creates the threat of long term exposure to mercury fumes. Furthermore, drops of the liquid metal can become lodged in floor cracks and behind equipment. Depending on the amount spilled and the air movement within the lab, the mercury vapor concentration in a lab with "hidden" mercury spills may exceed safe limits. A spill is more dangerous when mercury thermometers break in ovens or incubators because mercury evaporates readily at high temperatures, creating high mercury concentrations.

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Disposal of mercury thermometers and the contaminated clean-up materials generated by a spill is very expensive. Materials containing mercury are currently disposed of at a cost upward to $100 per gallon. Thus, one 55-gallon drum of mercury waste shipped for disposal, could potentially cost the University $5,500. Spill debris uses much more space than an intact thermometer resulting in increased cost. Special clean-up procedures, such as dismantling an incubator or oven that has spilled mercury also increases costs substantially.

In the Beginning

Our initial search for replacement thermometers turned out to be a less than easy task. Most suppliers and vendors had very small selections of environmentally safe thermometers. The most common being the red alcohol thermometer, which we decided against mostly because the color did not meet our environmental perceptions. Fairly early we investigated a green spirit filled Enviro-Safe thermometer distributed by H-B Instrument Company. After several in-house tests and trial uses on campus, problems with column separation, thus accuracy, occurred, and we had to look further. We continued looking at various thermometer catalogs, trying to come up with a good selection of safe thermometers...our great wish being to get a good price. We had decided early on that the initial exchange would be funded through our operational budget. We turned to one of our campus scientific vendors, Krackeler Scientific http://ksionline.com to help us in our search. Eventually we decided upon a blue spirit Ever-Safe thermometer distributed by Ever Ready Thermometer Company http://www.ertco.com of West Paterson, New Jersey.

Learning of our project, the Chemistry Department immediately put in an order for replacement thermometers to be used by it's undergraduate and graduate labs. We eventually stocked -20/110 degrees C (both total and partial immersion), as well as -10/260 degrees C, partial immersion thermometers...all in increments of 1.0 divisions. Choosing between a partial or total immersion thermometer created further problems.

Partial or Total Immersion?

Total immersion thermometers are designed to indicate temperatures correctly when the bulb and the entire liquid column are exposed to the temperature being measured. A partial immersion thermometer usually has a line or mark at the immersion distance from the bottom. It reads correctly when the bulb and the liquid column to that line are exposed to the temperature being measured and the emergent stem is at ambient or surrounding temperature.

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Step By Step

We needed to come up with an effective way to publicize the "swap." We hired a graphic artist to develop a flyer for us that would grab the attention of lab faculty and staff, not always the easiest task. It was amazing to see how much time it took to select an appropriate logo and colors. We eventually came up with a design we liked. Fortunately we had already gone through some of the details beforehand when UVM ChemSource first got underway.

By the Spring of 1997 we were ready to introduced our "Mercury Thermometer Swap." We sent a flyer to those individuals and departments that would most likely have significant numbers of mercury thermometers to exchange, one-for-one, and cost free. We also included several articles announcing the thermometer "swap" in Safety News, the University's chemical safety and health newsletter. As envisioned the initial cost would be covered by our operational budget, but we had no idea how many thermometers actually existed on campus. From the start we had envisioned a relatively small exchange, and were slightly overwhelm by the initial request by the Chemistry Department for over 800 thermometers. By March 1998, we had exchanged approximately 1,150 thermometers, with the bulk of them going to the Chemistry Department, and the remaining thermometers swapped or sold to other campus labs. Those investigators and labs that didn't have mercury thermometers to exchange could buy non-mercury thermometers from the ESF at greatly reduced cost. We instituted a 90-day return policy in which we stored the mercury thermometers at the facility until we received favorable, or no feedback concerning the use of the new thermometers, at which time we would declare the mercury a hazardous waste. We then sent a customer survey to the "swap" participants for their comments about the exchange. We eventually filled one 55-gallon barrel with these thermometers at a disposal cost of about $3,700.

More Precise, Sharing the Cost

We received several requests for specialized thermometer replacement; supplying these would cost far more than our budget could handle. We were able to get the help of the Chemistry Department to offset the increase in cost, with an agreement to share those costs over the next two fiscal years. In particular was the Chemistry Department's need for thermometers marked off in .1 divisions. Upon placing an order with ERTCO, we were told that the .1 divisions were no longer being made, and were being replaced with .2 division thermometers. We needed to know how accurate these were for laboratory needs. We talked directly with the technical sales advisor and were sent calibration certifications results to review. The .2 division thermometers performed well, but with some discrepancy experienced at the higher end of the temperature scale.

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Overview

In general our campus initiative to replace mercury thermometers with more environmentally safe thermometers was well received. This "short term" project became more complex then we initially thought. The program has added another dimension toward meeting our overall waste minimization objectives, while helping to bring about an increased awareness of the dangers involved with mercury. The campus has been given a non-mercury thermometer alternative to replace those "unloved" mercury thermometers, and has also helped reduce the University's overall clean-up and disposal costs. It is a small but hopefully model program for continued thermometer swaps.

Reference List

"We Want Your Mercury Thermometers Before They Break!" Safety News #49, Winter 1997, p. 7.

"Mercury Thermometer Swap!" UVM ChemSource, February 1997

"Thermometer Exchange Underway." Safety News #50, Spring 1997, p. 8

"Mercury Thermometer Survey." UVM ChemSource, July 1997

"Mercury Thermometer Swap Continues! Safety News #51, Fall 1997, p. 2

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